ISSN 0840-8440

PROCEEDINGS

TECHNOLOGY TRANSFER CONFERENCE 1988

November 28 and 29, 1988

Royal York Hotel

Toronto, Ontario

SESSION A

AIR QUALITY RESEARCH

Sponsored by

Research and Technology Branch

Environment Ontario

Ontario, Canada

AASG

AP4

A 3-D MESOSCALE WIND FIELD MODEL AND ITS APPLICATION FOR EMERGENCY PLANNING AT NUCLEAR PLANTS IN ONTARIO

H. Sahota, P. K. Misra, R. Bloxam and D. Rhee
Atmospheric Modelling Unit
Air Quality and Meteorlogy Section
Air Resources Branch
Ontario Ministry of Environment
Toronto, Ontario

INTRODUCTION :

The Ontario Ministry of Environment in co-operation with the Ministry of Solicitor General and Ontario Hydro, has developed an emergency response program for the release of radio-nuclides in the event of an accident at any of the nuclear plants in Ontario.

Two important pieces of information, required for this program, are, the wind field (i.e. wind speeds and directions downwind of the plants) and the ground level concentration level fields. Generally measurements of winds are sparse and hence either extrapolation from a single measurement point or meteorological forecasts are needed to generate the wind fields. This introduces a degree of subjectivity to the determination of the direction in which the radio-nuclides propagate downwind after their release.

It would be desirable to develop an objective scheme to simulate the wind fields in the vicinity of the nuclear power plants. We propose a three dimensional wind field model for this purpose. The model is briefly described in the next section. Several criteria were used in the development of the model. These are described below:

a) The model has to include sufficient physics to account for the complex flow patterns which are expected near a lakeshore. It is noted that all of Ontario's nuclear power plants are located on the lake shore.

b) The model has to be computationally feasible to run in a short time to enable usto effectively respond in an emergency situation.

The above criteria are very often in conflict with each other. The model described in this paper attempts to fulfill these criteria in an optimum manner.

MODEL DESCRIPTION :

The model is time dependent and is governed by the basic Navier Stokes equation. Atmosphere is assumed to be in a hydrostatic equilibrium i.e. vertical accelrations are neglected. Topography is included by defining a vertical coordinate which includes the local terrain height. Eddy exchange coefficients for momentum and heat are parameterized in the model(for a detailed description of the model see Maddukuri 1983).

The model has ten irregularly spaced vertical levels. Spacing is closer near the ground where higher resolution is required and is larger elsewhere.

Figure 1 shows the model domain and Figure 2 the topography, as it is implemented for the Pickering Nuclear Generating Station. The model grid size is 5 km and covers an area 145 km x 145 km.

The model uses a preprocessor to compute the initial conditions that vary both horizontally and vertically. The preprocessor uses gridded (327 km) data (isobaric heights and temperatures) provided by Canadian Meterological Centre (CMC) of Atmospheric Environment Services. Using orthognal polynomials the preprocessor interpolates this data down to 5 km grid points. CMC balance winds or geostrophic winds are used as initial winds in the model.

Surface temperature which is the driving force for mesoscale circuilations is derived from observed screen temperature, cloud cover and using empirical relationships developed by van Ulden and Holstag (1985).

The preprocessor program writes all the initial data onto appropriate files which are subsequently read by the main program. A time step of six minutes is used in the program.

MODEL OUTPUTS (AN EXAMPLE):

The model coumputes various parameters such as isobaric heights, temperature, horizontal and vertical components of the wind, potential temperature etc. Data can be averaged over any desired time interval. Usually hourly averages are reported unless specified. Vertical averaging for wind speed is used to reduce noise in the data. Typically the model is used to forecast winds for six to twenty four period.

Figure 3. shows the surface map for great lakes area on June 24, 1988. Southern Ontario under the influence of a high pressure system had clear skies and temeperatures were in the uppper twenties. Figure 4. shows the initial conditions as computed at 8.00 AM local time. As the surface temperature increases due to soalr insolation a lake breeze is set up. Figure 5. shows the model output at 15.00 PM. The shift in wind direction and magnitude is quite evident.

The mesoscale model is also being verified with the data from a field study being conducted by Atomic Energy Board of Canada, Environment Canada, Ministry of Solicitor General and Ministry of Environment. One such comparison is presented in Figure 6. The agreement between observed and predicted wind speed and direction is quite good.

CONCLUSIONS :

The model is capable of generating good mesoscale wind forecasts. Model verification with field data is currently underway. Initial results show a good agreement between observed and predicted windfileds. Additional tests are currently underway. After evaluation is completed, the model will be implemented on microcomputer for use in emergency planning by Ministry of Solicitor General.

FUTURE PLANS :

After the model has been verified with the field data, it will be implemented on a COMPAQ 386 microcomputer. Software will be developed to interface directly with OME's MDAS (Meterological Data Acquisition System) so that meterological data can be transferred directly without manual entry. This total pacakage will be then be able to make mesoscale windfiled forecasts on a routine basis and the data then could be used for emergency planning.

REFERENCES :

Maddukuri, C. S. and P. R. Slawson (1983): A three dimensional wind field model for the planetary boundary layer, Parts I and II; ARB Report No. 107-84-AQM, Ontario Ministry of Environment.

van Ulden, A.P. and A.A.M. Holtslag (1985) :Estimation of atmospheric boundary layer parametrs for diffusion applications; Journal of Climate and Applied Meteorlogy, 24 p 1196-1207.

TOPOGRAPHIC MAP OF PICKERING AREA

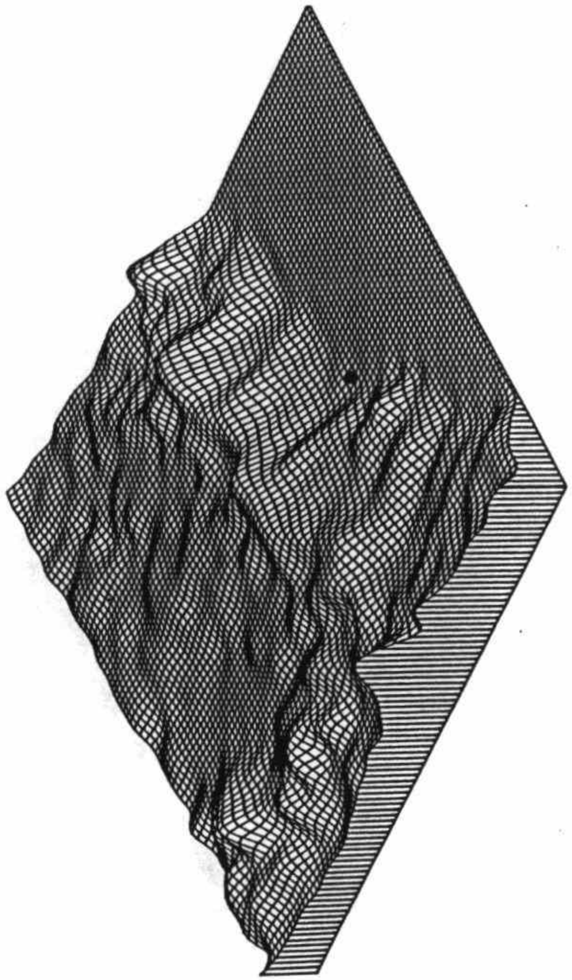

Fig. 2 : Topographic Features of Model Domain

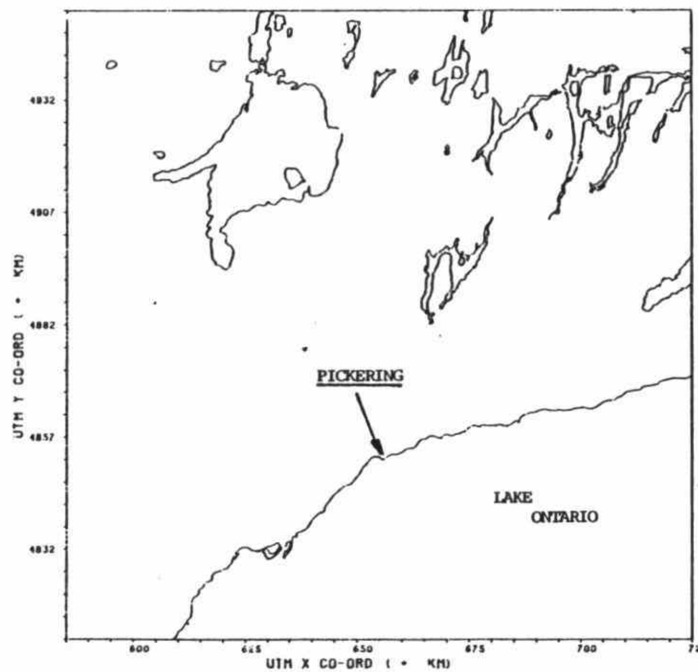

Fig. 1 : Mesoscale Wind Field Model Domain

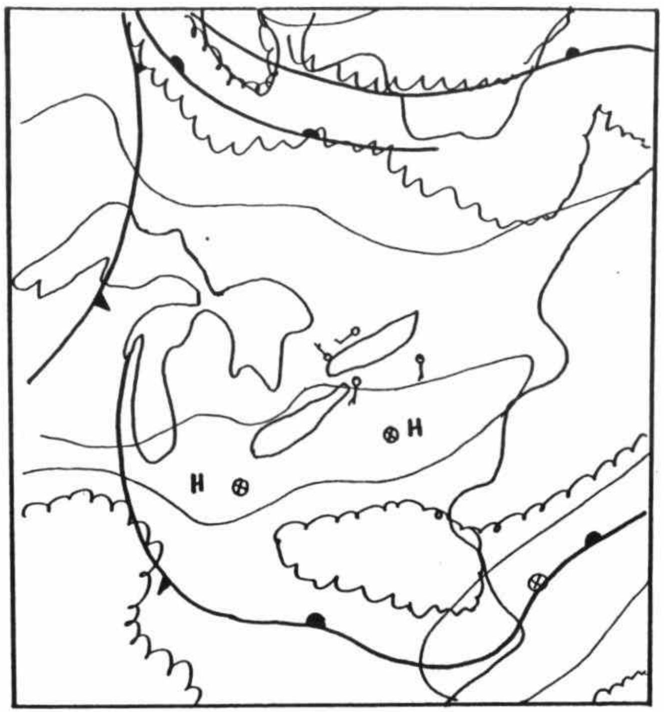

Fig. 3

SURFACE MAP

JUN 24, 1988 TIME: 0700

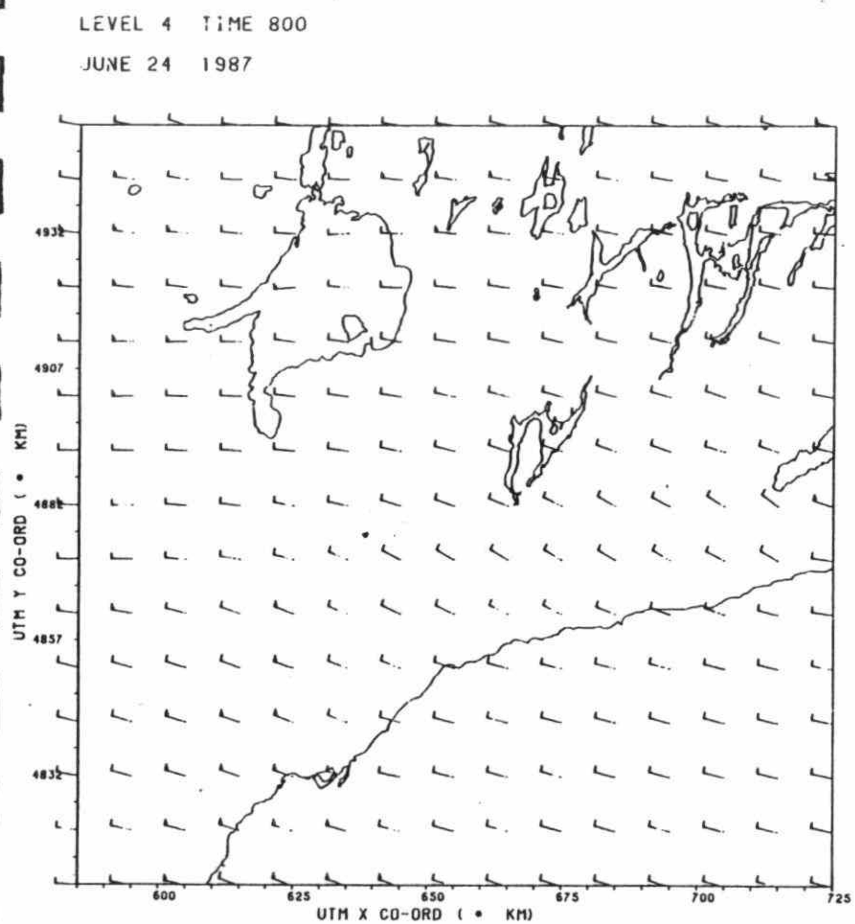

Fig. 4 : Initial Winds at Level Four (10 m)

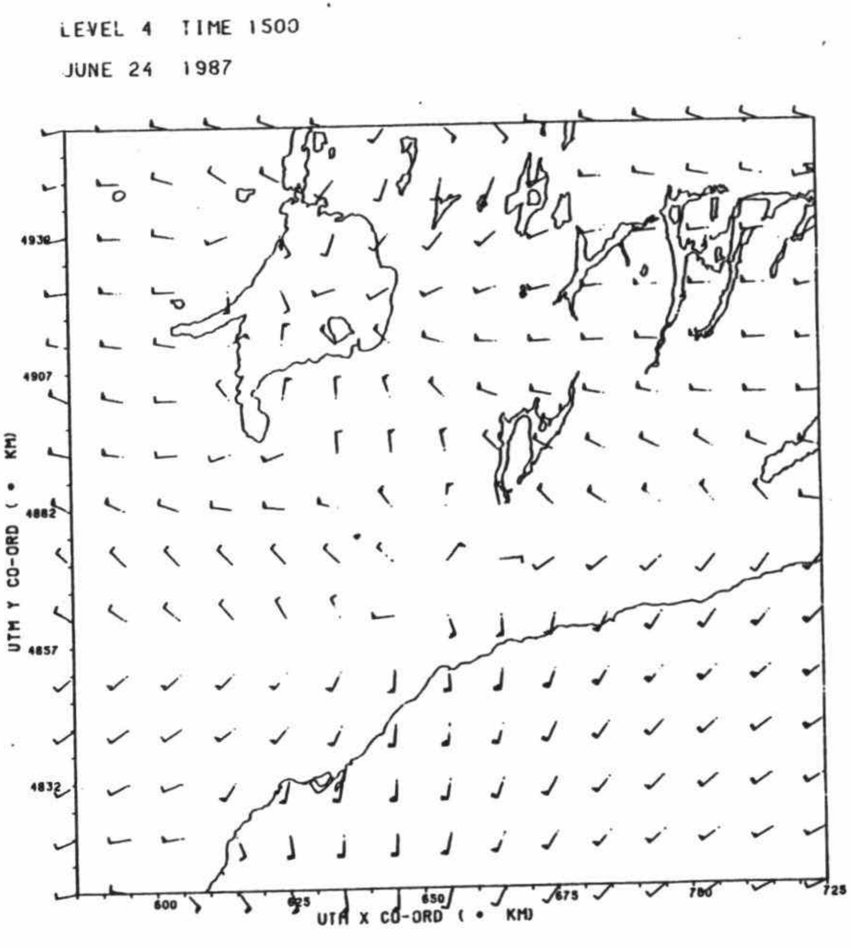

Fig. 5 : Model Predicted Winds at Level Four (10 m)

MARCH 17, 1988

1500 LOCAL TIME

STATION	W/S (OBSERVED)	DIR	W/S (MODEL)	DIR
PICKERING	3.08	296	3.05	315
CHERRYWOOD	3.86	317	4.05	320
TORONTO AIR	4.5	300	3.76	306
TORONTO ISL	N/A		3.37	306

Fig. 6 : Comparison Between Observed and Predicted Winds

(6846)
TD/5/T43